

MI – 0252
“The Main Injector SBD for
Studiers”

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Summary

The Main Injector Sampled Bunch Display (MISBD) is measurement system comprised of a wide-bandwidth resistive wall monitor (longitudinal beam pickup), a fast LeCroy 9384 Oscilloscope, and a LabVIEW analysis program. Together they provide the user with a powerful easy-to-use diagnostic tool. This system and its components and others from which it has been derived are described in more detail in the following link. Specifics to this system are described below.

Acquisition Hardware

LRS 9384: This is a fast (4Gs/s digitizing speed, 1GHz analog bandwidth) oscilloscope with 4Mbytes of high-speed storage memory. Its memory is segmentable so that it can be set up to trigger rapidly (minimum Δt between triggers is 130 μ s, or roughly once every twelfth MI turn.) The 4 Mbytes memory size and the fraction of the ring that is sampled limit the maximum number of triggers before readout. For example, up to 86-batch or 480 single-batch acquisitions can be acquired for any single MI cycle. The means to control these parameters will be given below.

Data analysis and availability

After the scope has acquired data, it is read out by the SBDMI, a Macintosh PPC with a GPIB interface running LabVIEW. The primary function of this machine is to convert the raw oscilloscope data into bunch intensities (I), centroids (μ), and rms (σ) values. The fundamental measurement is the intensity for each Main Injector bunch. The result is shown on the front panel of the LabVIEW application and is available over the cable TV system. The application is also running an ACNET interface, and so the results of the analysis (I , μ , σ) are provided as ACNET devices. The reader is referred to the I34 parameter page for a listing of the more commonly used devices. See Figure 1 for a picture of the I34 parameter page.

Raw data and analyzed results can also be seen using a browser and pointing it to <http://www-rfi.fnal.gov/Livedata/Livedata.html>. From there you will be able to view graphs that are updated about every 20 seconds. See Figure 2 for an example.

If you want to analyze the data yourself you can direct the system using Acnet to save the actual raw oscilloscope data to the local disk. You can retrieve this data using a browser, see the next section for more details.



Figure 1. The display of console application I34.

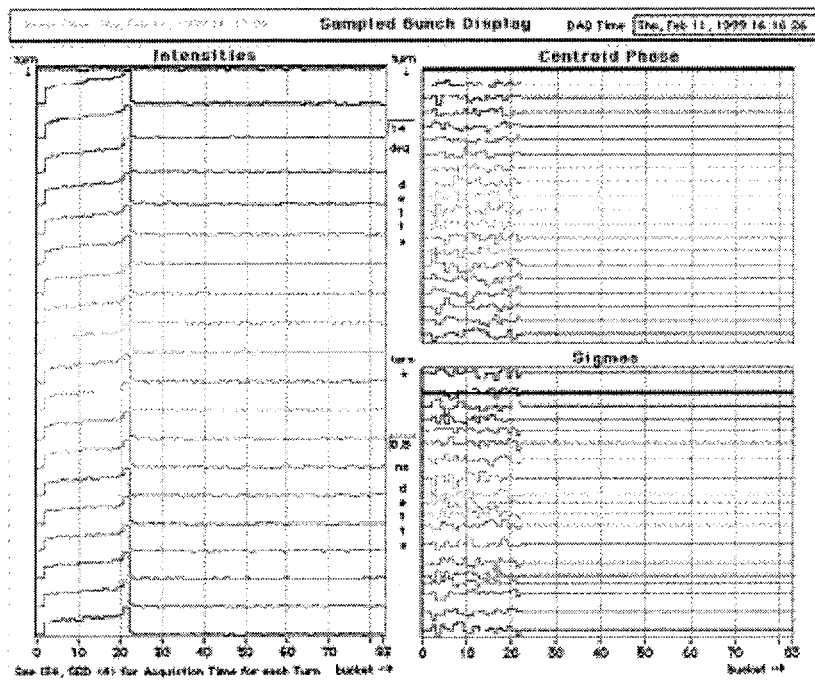


Figure 2. A plot of the MI SBD analyzed results.

Control of the MISBD

There are two ways to control the MI SBD: The first involves sitting (either locally or via Timbuktu) at the LabVIEW front panel and the second by ACNET console. The latter setup has been setup as the desired way that non-experts can interact with the MISBD.

At this time a Parameter Page (I34) has been setup to provide the user with a way to setup the relevant MISBD control devices. The following is a "cookbook" setup.

- 1) Launch Web Browser, and open I34_SBD <1> on the console.
- 2) Set your Web Browser to <http://www-rfi.fnal.gov/Livedata/Livedata.html>, and follow links to SBD, either "analyzed" or "raw data", depending upon what one wants to do. The browser display updates once every 20-30 seconds and shows the current MISBD running conditions. It should be noted that this display lags the actual beam conditions by approximately 60 seconds, although this may get better as we learn how to improve the link.
- 3) Use the ACNET control devices to modify the acquisition to your wishes, see below.

I:SBDMOD- The mode of operation of the SBD. If you wish to setup your own particular timings to take data, this mode **MUST** be set to "10", the user control mode. It may already be in this mode. Currently the default on reboot is mode "3".

Mode	Use
-1	Turn graph off
0	Free Run
1	Free Run
2	Single batch injection
3	Multiple batch injection
10	Studier mode
11	Reset of Scope

Table 1. MI SBD operation modes.

I:SBDBAT- The number of batches which the scope acquires per trigger (or turn). Note that this device will affect how many turns of data can be acquired in the scope (due to maximum memory available). Currently (and there is no plan to change), the oscilloscope is setup to begin acquiring just before the First batch. Also "1" is the minimum number of batches currently supported.

I:SBDGAI- This device sets the input gain on the scope front end. It typically is set for 0.1 V (2/18/99 with un-coalesced beam). Coalesced beam may require a higher setting so that the scope front end doesn't saturate. This can be checked by looking at the Web "Raw Data " page and checking that the bunches are not saturated. Only one setting is possible for a complete cycle, so the value must be consistent with the **LARGEST** bunch that will be acquired.

- I:SBDTCK**- The TCLK event on which to arm the data taking. The value on the parameter page must be input as a decimal (from our usual HEX version).
- I:SDBDCK**- Which MI buckets to start the Web "Raw Data" Display. Note that this (and the following device) only controls what is plotted on the Web page, and not the actual data acquired.
- I:SBDNBK**- The number of MI buckets to display on the Web "Raw Data" Display. See comment just above.
- I:SBDACC**- Save the data acquired (if set to "1") on the NEXT data acquisition to local disk. Resets to zero after the command is accepted (i.e. only one save command per interrupt)

The following devices allow the user two ways to set the actual timings of the scope triggers. One method supports variable spacing of up to 25 segments of data acquisitions using I:SBDTIM. The second method using a fixed delta t spacing between segments and can take as many segments as the scope memory can hold. The second method is activated only if all the I:SBDTIM elements are zero. You can set the number of segments or turns on subpage 2. Make sure to check subpage <4> I34 SBD and manually zero out any of the elements that are non-zero when using the fixed delta t spacing.

- I:SBDTIM**- A vector of up to 25 elements holding the times (in seconds) for each of the individual triggers delayed of the TCLOCK event. The SBDMI LabVIEW software will automatically sort the list (internal to LabVIEW) and arrange it into correct time order skipping any "zero's". Recall that the minimum delta between any two time adjacent triggers is 130 μ s (or 0.00013 on the parameter page subpage <4>).
- I:SBDTRN**- The number or turns (or triggers) to acquire. The MISBD software checks if this number (and the number of batches to acquire) is consistent with the amount of memory in the oscilloscope, and will correct it to the maximum allowed. Currently the maximum number of triggers allowed is 240, a value that was easily implemented within the existing software. In the future this could be as high as 480 for single batch measurements.
- I:SBDFTE**- The time in seconds (from the chosen TCLK event) to start triggering the oscilloscope.
- I:SBDDETE**- The delta t (in seconds) between each acquisition. A value of zero will automatically be set to the minimum value (currently 130 μ s). Note that the oscilloscope actually triggers in units of 1 MI turn, so 130 μ s will trigger every twelfth turn.

Saved Data

The data is saved to a disk folder that is available to be downloaded by your web browser, see Figure 3. The Link <sbDMI/SavedDataFiles> will bring the user to a folder of saved data. The file names are "SBDMI_dd_mm_yy_hhmmss", where hhmmss is the time (24hr clock) of data acquisition, and "dd_mm_yy" is the date. Since this is for information purposes only, we do not worry about Y2k compliance.

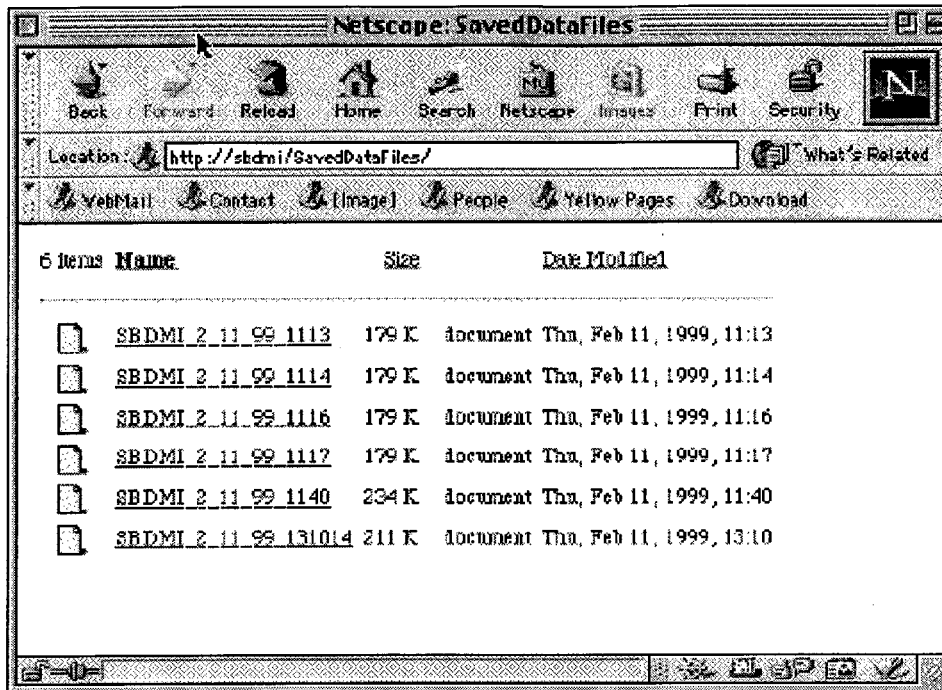


Figure 3. Browser page when pointed to the SavedDataFiles directory.

In order to bring the data over to your own computer, "click and hold" on the file you wish to transfer. A dialog will pop-up (in Netscape), from which you choose the "Save this Link" (source format) to the location of choice on your own machine.

The data is saved in a binary format, see table 2. The first 8 bytes decode (2xI32) into the dimensions of the acquired data, number of turns, N, and number of samples per turn, S. The data array follows as a signed byte array (8bit) whose total length is $N*(S+2)+1$. The two bytes at the end of each turn should be ignored, as should the last byte (they are data delimiters inserted by the LeCroy Scope). Next is the array of acquisition timings for each segment (turn) of data in Single Precision IEEE Float Big Endian Format for a total of $4*N$ bytes. The remaining characters to the End Of File (EOF) form a comment string. Note that this string can only be entered locally and not through the parameter page.

We have a simple LabVIEW File Read application, which can be used on a Mac or PC to read the file back in. However one still needs access to a LabVIEW development system in order to change the program. On request, other arrangements to make the data available can be made.

Offset	Entry size and format	Data
0	4 bytes, I32 big Endian	N, number of turns
4	4 bytes, I32 big Endian	S, Number of samples per turn
8	Signed Byte array of size S	Data of turn 1 plus delimiters
8+S+2	Signed Byte array of size S	Data of turn 2 plus delimiters
8+2*(S+2)		
8+(N-1)*(S+2)	Signed Byte array of size S	Data of turn N plus delimiters
8+(N-1)*(S+2)	1 byte	Delimiter
8+N*(S+2)+1	Single precision IEEE Float array of size 4*N bytes	Timestamp array
8+N*(S+2)+1+4*N	String of variable length to EOF	User comment

Table 2. File Format of saved data.